

## CROSS-TALK REDUCED MODULAR JACK

### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention

[0001] The present invention relates to an electrical connector, and particularly to a cross-talk reduced modular jack.

#### 2. Description of the Related Art

[0002] Cross-talk can be generally described as the unwanted coupling of electrical signals on adjacent signal lines. Such cross-talk may result in portion of an electrical signal on one pair of lines appearing on a separate pair of lines as unwanted noise.

[0003] Cross-talk between different pairs of wires is a source of interference that can cause signal degradation and negatively impact the ability of a communication system to process incoming signals. Cross-talk can also increase error rates and reduce signal strength.

[0004] Problems associated with unwanted cross-talk are becoming even more problematic given the general increase in operating frequencies and data rates of modern communication systems. Additionally, cross-talk can be particularly problematic within electrical connectors, e.g., modular jacks, that contain a plurality of contacts that are generally parallel and spaced closely together—a configuration that may lead to excessive cross-talk even over short lengths.

[0005] The modular jacks are always subject to a variety of industry signal transmission protocols, such as 10 BaseT protocol, 100 BaseT protocol and 1000 BaseT protocol. Modular jacks capable of operating in either 10 BaseT protocol or 100 BaseT protocol (i.e., 10/100 BaseT protocol) are commonplace and some modular jacks are entering the 10/1000 BaseT protocol arena, but the market is

driven to modular jacks capable of operating at either 10/100 or 10/1000 BaseT protocol.

[0006] It is well known to all skilled in the pertinent art that different methods of compensation to reduce or eliminate the cross-talk have been successful in both 10/100 BaseT protocol and 10/1000 BaseT protocol. However, the different electrical pairing arrangement of the electrical contacts for compensation between 10/100 BaseT protocol modular jack and 10/1000 BaseT protocol modular jack makes the compensation in a commoned 10/100 and 10/1000 BaseT protocol modular jack much more difficult. Ideal compensation in the 10/100 protocol could result in worse than no compensation performance when the modular jack is called upon to perform in the 10/1000 BaseT protocol, and vice versa.

[0007] Furthermore, conventional modular jacks with cross-talk reduced electrical contacts are always difficult and expensive to manufacture.

[0008] Therefore, an improved electrical connector solving or obviating the aforementioned problems is desired.

#### SUMMARY OF THE INVENTION

[0009] A first object of the present invention is to provide an electrical connector which effectively reduces cross-talk between electrical contacts thereof.

[0010] A second object of the present invention is to provide an economically and manufacturably feasible electrical connector conforming to either 10/100 or 10/1000 BaseT protocol.

[0011] An electrical connector in accordance with the present invention comprises an insulative housing defining a receiving cavity, a conductive shield enclosing the insulative housing and a contact insert accommodated in the receiving cavity of the insulative housing. The contact insert comprises a plurality of electrical contacts each comprising a contacting portion resiliently extending in

the receiving cavity of the insulative housing and a tail portion extending beyond the insulative housing. A transitional portion or a conductive trace connects the contacting portion and the tail portion of each electrical contact. The transitional portions or conductive traces of a first group of electrical contacts are located in a first horizontal plane and the transitional portions or conductive traces of a second group of electrical contacts are located in a second horizontal plane vertically offset or spaced from the first horizontal plane. The transitional portions or conductive traces of the first group of electrical contacts are to some extent vertically overlapped or aligned with the transitional portions or conductive traces of the second group of electrical contacts.

[0012] Other objects, advantages and novel features of the invention will become more apparent from the following detailed description of the present embodiment when taken in conjunction with the accompanying drawings.

#### BRIEF DESCRIPTION OF THE DRAWINGS

[0013] FIG. 1 is a perspective view of an electrical connector in accordance with the present invention;

[0014] FIG. 2 is a view similar to FIG. 1 but taken from a different perspective;

[0015] FIG. 3 is a perspective view of an insulative housing of the electrical connector of FIG. 1;

[0016] FIG. 4 is a view similar to FIG. 3, but taken from another perspective;

[0017] FIG. 5 is a perspective view of a contact insert of the electrical connector of FIG. 1 in accordance with a first embodiment of the present invention;

[0018] FIG. 6 is a view similar to FIG. 5 but an insulative portion of the contact insert is removed away;

- [0019] FIG. 7 is a top plan view of FIG. 6;
- [0020] FIG. 8 is a front view of FIG. 6;
- [0021] FIG. 9 is a rear view of FIG. 6;
- [0022] FIG. 10 is a side elevational view of FIG. 6;
- [0023] FIG. 11 is a perspective view of a second group of the electrical contacts of FIG. 6;
- [0024] FIG. 12 is a perspective view of a contact insert of the electrical connector of FIG. 1 in accordance with a second embodiment of the present invention; and
- [0025] FIG. 13 is a perspective view of a printed circuit board of the contact insert of FIG. 12 showing a second plane thereof.

#### DETAILED DESCRIPTION OF THE INVENTION

[0026] Referring to FIGS. 1 and 2, an electrical connector 1, such as a modular jack, in accordance with a first embodiment of the present invention comprises an insulative housing 2, a conductive shield 3 enclosing the insulative housing 2 and a contact insert 4.

[0027] Referring also to FIGS. 3 and 4, the insulative housing 2 comprises a top wall 20, a pair of opposite side walls 22 and a bottom wall 24 opposite to and connected by the side walls 22 to the top wall 20. The insulative housing 2 defines a receiving cavity 26 recessed from a front surface 28 thereof and confined by the top, side and bottom walls 20, 22, 24 thereof for receiving a plug or complementary electrical connector (not shown) therein. A comb-shaped mid-wall 21 extends vertically in a lower and rear portion of the receiving cavity 26 and is perpendicular to the top, side and bottom walls 20, 22, 24. A plurality of spaced channels 23 extend upwardly from a lower end of the mid-wall 21 to an upper portion of the mid-wall 21 and communicate with the receiving cavity 26. A pair

of positioning posts 25 extend downwardly from a front portion of the bottom wall 24 to be insertable into for example through holes of a printed circuit board (not shown) when the electrical connector 1 is mounted to the printed circuit board.

**[0028]** The conductive shield 3 comprises a top wall 30 and a pair of opposite side walls 32 corresponding to the top and the side walls 20, 22 of the insulative housing 2, respectively. The conductive shield 3 comprises a front wall 34 corresponding to the front surface 28 of the insulative housing 2 and having an opening corresponding to the receiving cavity 26. A rear wall 36 is formed on the conductive shield 3 and is connected to the top and side walls 30, 32. A pair of grounding tabs 38 (only one shown) extend downwardly from lower edges of the side walls 32.

**[0029]** Referring also to FIG. 5, the contact insert 4 comprises an insulative portion 40 and eight electrical contacts 41-48. The insulative portion 40 comprises a horizontal section 401 and a vertical section 402 extending downwardly and perpendicularly from a rear portion of the horizontal section 401.

**[0030]** Referring specifically to FIGS. 6-11, the electrical contacts 41-48 each comprise a tail portion 411, 421, 431, 441, 451, 461, 471, 481 for electrically contacting with the printed circuit board on which the electrical connector 1 is mounted, a transitional portion 412, 422, 432, 442, 452, 462, 472, 482 extending forwardly from the tail portion 411, 421, 431, 441, 451, 461, 471, 481, and a contacting portion 413, 423, 433, 443, 453, 463, 473, 483 extending downwardly and rearwardly from the transitional portion 412, 422, 432, 442, 452, 462, 472, 482.

**[0031]** The transitional portions 412, 442, 452, 482 of a first group of contacts 41, 44, 45, 48 are generally located in a horizontal plane from which the contacting portions 413-483 and the tail portions 411, 441, 451, 481 extend away.

**[0032]** Each of the transitional portions 412 and 482 comprises a generally U-shaped plate section 4120, 4820. Each U-shaped plate section 4120, 4820 comprises a base plate 4121, 4821 extending in a front-to-back direction along which the plug complementary connector is inserted into the electrical connector 1 and a pair of leg plates 4122, 4822 extending in a direction perpendicular to the front-to-back direction along which the base plate 4121, 4821 extends. Each base plate or leg plate has a width larger than other portions of a corresponding electrical contact.

**[0033]** Each transitional portion 442, 452 comprises a generally rectangular plate section 4420, 4520 extending laterally from one side thereof into the U-shaped plate sections 4120, 4820, respectively, and substantially surrounded by the base plates 4121, 4821 and the leg plates 4122, 4822.

**[0034]** The transitional portions 422, 432, 462, 472 of a second group of electrical contacts 42, 43, 46, 47 extend firstly rearwardly from the contacting portions 423, 433, 463, 473 in the horizontal plane in which the transitional portions 412, 442, 452, 482 are located and then downwardly to form lower sections 4220, 4320, 4620, 4720 located in another horizontal plane in parallel proximity to the horizontal plane in which the transitional portions 412, 442, 452, 482 are located.

**[0035]** The lower sections 4220 and 4720 extend respectively first outwardly and laterally to be perpendicular to the front-to-back direction along which the plug complementary connector is inserted into the electrical connector 1, then rearwardly to be parallel to the insertion direction of the plug complementary connector, and then inwardly and laterally to be again perpendicular to the insertion direction of the plug complementary connector and to perpendicularly connect with the tail portions 421, 471. Thus, the lower sections 4220, 4720 are

generally U-shaped and as could be clearly seen from FIG. 11, the U-shaped sections 4220, 4720 have widths substantially equal to widths of other portions of the electrical contacts 42, 47. The U-shaped sections 4220, 4720 are vertically overlapped by the U-shaped plate sections 4120, 4820, respectively.

[0036] Each of the lower sections 4320, 4620 is also formed with a generally U-shaped section 4321, 4621 generally surrounded by the U-shaped lower sections 4220, 4720, respectively, and substantially vertically overlapped by the U-shaped plate sections 4120, 4820, respectively. A rectangular plate section 4322, 4622 diverges from a leg end of the U-shaped sections 4321, 4621 to extend into a corresponding U-shaped section 4621, 4321 of a corresponding transitional portion 462, 432 and to vertically align with the rectangular plate sections 4520, 4420, respectively.

[0037] The tail portions 421, 431, 461, 471 of the second group of electrical contacts 42, 43, 46, 47 extend downwardly a shorter distance from the transitional portions 422, 432, 462, 472 than the tail portions 411, 441, 451, 481 extend downwardly from the transitional portions 412, 442, 452, 482 of the first group of electrical contacts 41, 44, 45, 48, such that lower ends of the first and second groups of electrical contacts 41-48 are, as specifically shown in FIGS. 6 and 10, located in the same level.

[0038] The electrical contacts 41-48 are insert molded in the insulative portion 40 to form the contact insert 4. The transitional portions 412-482 are embedded in the horizontal section 401 in two aforementioned different planes (levels), the contacting portions 413-483 extend resiliently and slantways beyond a front end of the insulative portion 401, and the tail portions 413-483 extend beyond the vertical section 402.

[0039] In assembly, the contact insert 4 is inversely inserted in a back-to-front

direction into the receiving cavity 26 of the insulative housing 2 with the contacting portions 413-483 respectively movably received in the channels 23 of the mid-wall 21. The tail portions 411-481 are electrically connected to terminals 5 (FIGS. 1 and 2) in ways well known to any one of ordinary skill in the pertinent art to be electrically engaged with the printed circuit board on which the electrical connector 1 is mounted, so a detailed description thereabout is omitted herefrom.

[0040] As stated above, the U-shaped plate sections of the transitional portions of the electrical contacts 41, 48 vertically overlap (align with) the U-shaped sections of the transitional portions of the electrical contacts 42 and 43, 46 and 47, respectively. The rectangular plate sections 4420 and 4520 of the transitional portions 442 and 452 of the electrical contacts 44 and 45 vertically overlap and/or align with the rectangular plate sections 4622 and 4322 of the transitional portions 462 and 432 of the electrical contacts 46 and 43, respectively. Through such arrangement, the electrical contacts 42 and 44, 44 and 46, 46 and 48 are located closer in a horizontal direction than when the transitional portions 412-482 are located in turn side by side in a common horizontal plane.

[0041] Referring to FIGS. 12 and 13, a contact insert 4' in accordance with a second embodiment of the present invention comprises eight electrical contacts 41'-48' and a printed circuit board 40'. The electrical contacts 41'-48' respectively comprise tail portions 411'-481' (only 411', 441', 451' and 481' shown) and contacting portions 413'-483'. The printed circuit board 40' comprises a first plane 400' and a second plane 401'. The first plane 400' defines a plurality of conductive traces 412', 442', 452' and 482' thereon corresponding to the electrical contacts 41', 44', 45' and 48', respectively, and the second plane 401' defines a plurality of conductive traces 422', 432', 462' and 472' corresponding to the electrical contacts 42', 43', 46' and 47', respectively. The conductive traces



412'-482' are electrically connected with the tail and the contacting portions 411'-481', 413'-483' of the electrical contacts 41'-48', respectively. The shapes of the conductive traces 412'-482' correspond to those of the transitional portions 412-482 of the electrical contacts 41-48, respectively, and the overlapping relations between the conductive traces 412'-482' is identical to those between the transitional portions 412-482.

[0042] In use, when the electrical connector 1 needs to work in 10/100 BaseT protocol, desired electrical couplings could be established in the respective differential contact pairs of 41 and 42 (41' and 42'), 43 and 46 (43' and 46'), 44 and 45 (44' and 45') and of 47 and 48 (47' and 48'). Unwanted electrical couplings (cross-talks), such as between the electrical contacts 42 and 43 (42' and 43') and between the electrical contacts 46 and 47 (46' and 47') are balanced by electrical couplings between the electrical contacts 41 and 43 (41' and 43') and between the electrical contacts 46 and 48 (46' and 48'), respectively achieved by the vertical overlapping of the U-shaped sections thereof. Also, unwanted electrical couplings between the electrical contacts 43 and 44 (43' and 44') and between the electrical contacts 46 and 45 (46' and 45') are balanced by the electrical couplings between the electrical contacts 43 and 45 (43' and 45') and between the electrical contacts 46 and 44 (46' and 44') respectively achieved by the vertical overlapping of the rectangular-shaped plate sections thereof. Thus, the cross-talk of the electrical contacts 41-48 of the electrical connector 1 is effectively reduced.

[0043] When the electrical connector 1 needs to work in 10/1000 BaseT protocol, desired electrical couplings could be established in the respective differential contact pairs of 41 and 42 (41' and 42'), 43 and 44 (43' and 44'), 45 and 46 (45' and 46') and of 47 and 48 (47' and 48'). Unwanted electrical couplings, such as between 42 and 43 (42' and 43'), between 44 and 45 (44' and

45') and between 46 and 47 (46' and 47') would also be balanced by electrical couplings between 41 and 43 (41' and 43'), between 43 and 45 (43' and 45') and between 46 and 48 (46' and 48'), respectively established in like ways as described above. So cross-talk of the electrical contacts 41-48 is also effectively reduced.

[0044] Thus, the electrical connector 1 is capable of working in either 10/100 BaseT protocol or 10/1000 BaseT protocol.

[0045] As clearly shown in FIGS. 6 and 11, shapes and dimension of the transitional portions 412, 442, 452, 482 of the first group of electrical contacts 41, 44, 45, 48 are complementary with one another and shapes and dimension of the transitional portions 422, 432, 462, 472 of the second group of electrical contacts 42, 43, 46, 47 are complementary with each other, so the first and second groups of electrical contacts could be respectively stamped from one separate metal sheet with little material waste, thereby reducing the manufacturing cost thereof and simplifying the manufacturing procedures thereof.

[0046] Furthermore, the contact insert 4, 4' is configured as one unit, the insulative housing 2 needs not consider designing complicated infrastructure to correspond to the varying shapes and dimension of the electrical contacts 41-48 (41'-48'). Therefore, the manufacturing cost of the insulative housing 2 is also reduced.

[0047] Although the conductive traces 412'-482' shown in FIGS. 12 and 13 are directly connected with the electrical contacts 41'-48', they also can be connected to other electronic components, for example capacitors and magnetic. Furthermore, the electrical connector 1 shown herein is a singular port connector, while it could be in multi-port connector, such as side by side and stacked connector fashion, if desired.

[0048] It is to be understood, however, that even though numerous characteristics and advantages of the present invention have been set forth in the foregoing description, together with details of the structure and function of the invention, the disclosure is illustrative only, and changes may be made in detail, especially in matters of shape, size, and arrangement of parts within the principles of the invention to the full extent indicated by the broad general meaning of the terms in which the appended claims are expressed.